U. S. Army Corps of Engineers

The development of Coos Bay as a shipping point for lumber products, coal, and agricultural commodities and awareness of the dangers of the harbor entrance led to congressional appropriations for improvements. Because the task involved navigation and complex designs for public works, it fell to the U. S. Army Corps of Engineers to carry out the assignments.

In 1878 Channing M. Bolton, an assistant engineer, went to Coos Bay to devise plan for improvement of the harbor entrance. Bolton had arrived in Oregon in 1876 with seventeen years experience in major engineering projects on the East Coast. His initial assignment was to redesign the canal and locks at the Cascades of the Columbia. In August, 1878, he filed a chart, "Entrance to Coos Bay, Oregon, Showing Proposed Plan of Improvement (Bolton 1878)." Bolton and his superior, Major John M. Wilson, proposed two jetties or "training walls." The south jetty would extend 8,000 feet southwesterly from Fossil Point and run parallel to Coos Head, passing Guano Rock, and into the Pacific Ocean (Figure 17). The north jetty, 5,000 feet long, would run from the North Spit into the ocean. Cost estimates for the projects ran to $972,000. The Board of Engineers concluded that the south jetty might prove sufficient and argued that the rivers pouring into the bay would generate sufficient flushing action to create a viable shipping channel along the north side of the jetty (Willingham 1984:29-30, 37).

When work commenced in 1879, Lieutenant A. H. Payson, project supervisor, discovered the floor of the bay at Fossil Point was too rocky for driving piling to build a trestle to drop stones into the bay and hold them in place as a jetty. Payson thus instituted the crib method where workmen on shore bolted together large timbers to make cribs, filled them with rocks to cause them to sink, and lowered them into place before pouring in more

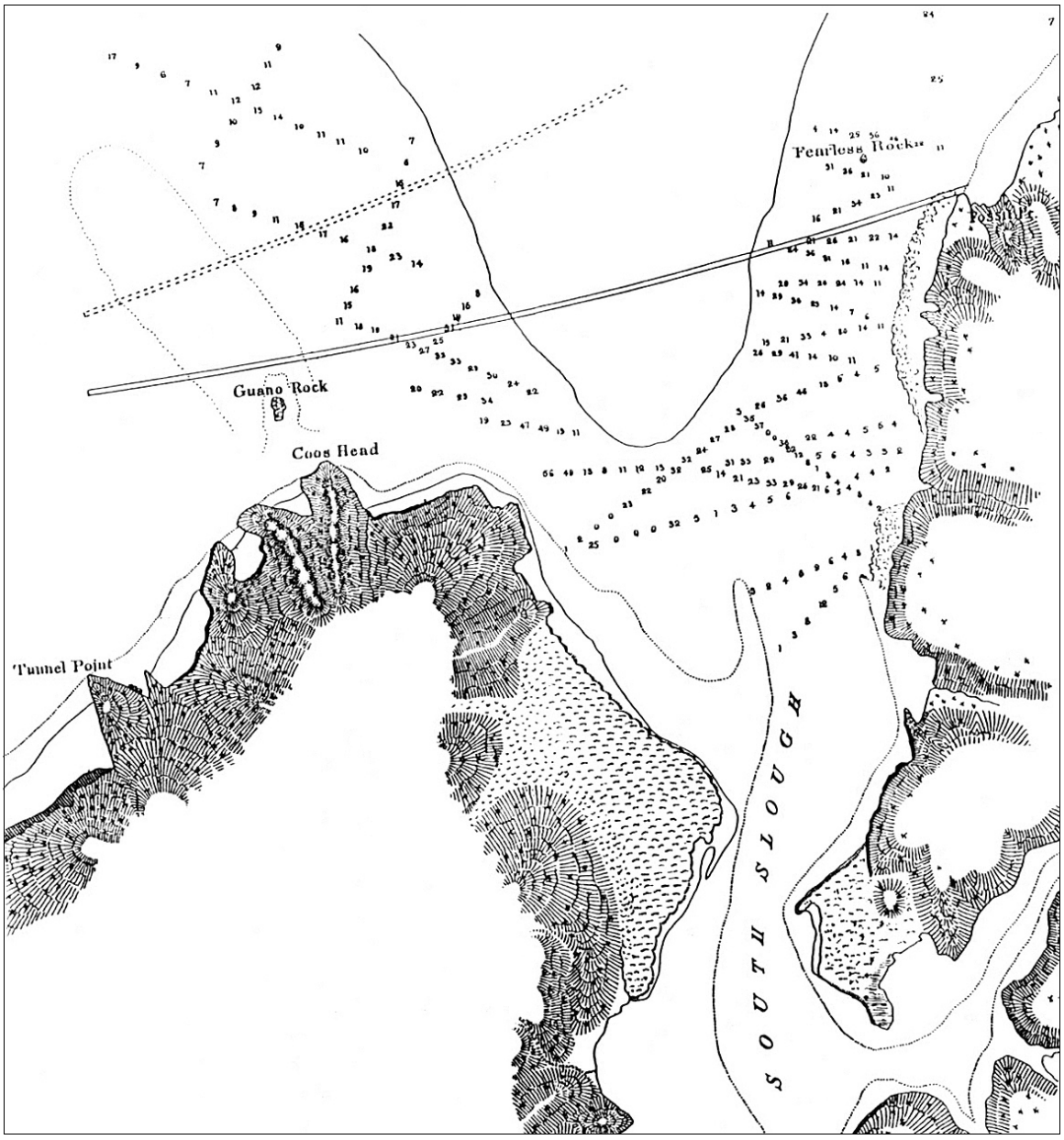

Fig. 17. Proposed north and south jetties, 1878, as devised by Channing M. Bolton and John M. Wilson. The south jetty was to run southwesterly from Fossil Point to beyond Guano Rock (Bolton 1878).

rocks to build the jetty to the surface. The cribs measured fifty feet long, twenty-six feet wide, and ten feet high. Their construction and placement was slow, costly, and difficult. By August, 1880, workmen had constructed only 450 feet of the south jetty. William A. Luse, son of Henry Heaton Luse--

the pioneer sawmill and shipyard operator at Empire City--held the contract for the cribbing. The enterprise was a good one for the Luses, for it insured a steady market for large beams cut at their nearby sawmill (Beckham 1971:47-48).

Slowly the south jetty grew southwesterly in the 1880s. By the fall of 1881 it extended 1,384 feet into the bay and was at depth of thirty feet. Luse employed thirty-five men and each day placed about 200 cubic feet of rock (Beckham 1971:48). The Corps of Engineers was ultimately compelled to abandon the crib method because of the depth of the water and difficulties in lining up the cribs. In 1884 it changed the method and ordered the workmen to begin constructing trestle and dumping stone into the estuary. Commerce increased steadily while the public works projects inched forward. In 1877 exports from Coos Bay were valued at $468,000; in 1890 the export tally had a value of $1,992,903. Coos Bay had become the most important harbor between the Columbia River and San Francisco (Willingham 1984:38).

A chart of the estuary in 1879 with the 1881 entry of "Jetty" (Figure 18) provided specific information on the North Spit:

- The "H[igh] W[ater] May 1882" confirmed the southernmost point of the North Spit lay north and west of Pigeon Point. High water was identified by _._._ on the chart.
- The "L[ow] W[water] May 1882" confirmed the southernmost point of the North Spit lay west of Pigeon Point and that five sandbars visible at low water lay between Coos Head and the North Spit. Lower water was identified by _ ... _ ... _ on the chart.
- The jetty extended southwesterly from Fossil Point. (Anonymous 1882)

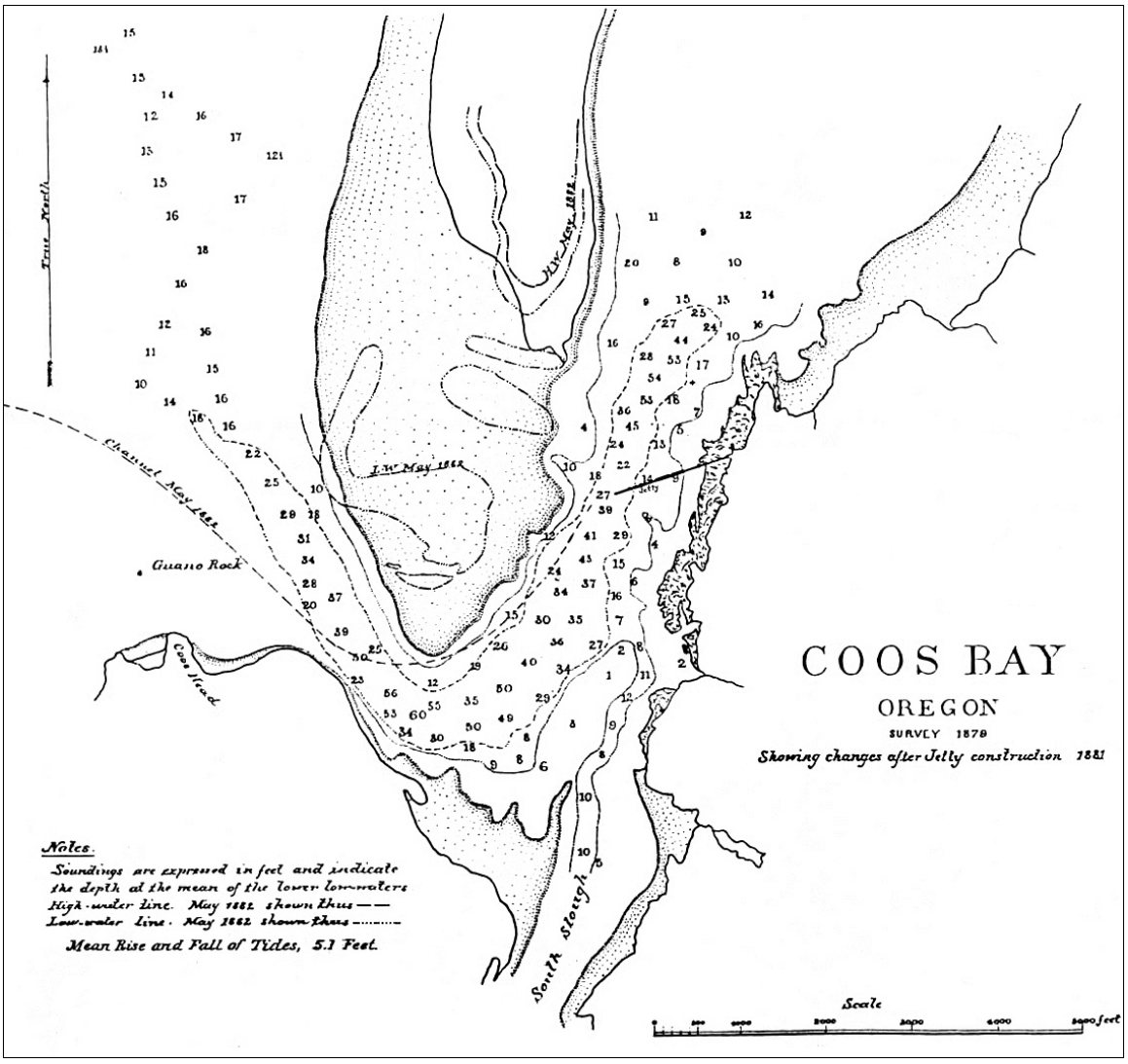

Fig. 18. Chart of "Coos Bay, Oregon" based on a survey in 1879 and "Showing changes after Jetty construction 1881" (Anonymous 1882).

In 1883 R. S. Littlefield of the Corps on Engineers took soundings in the lower estuary and in the ocean west of the North Spit, "showing changes after jetty construction up to June 1883." The Littlefield chart (Figure 19) showed the following:

- "Jetty," the new jetty constructed southwesterly from Fossil Point.
- "Channel June 1883," lying north of Guano Rock and Coos Head.

- "H[igh] W[ater]" in 1879 and 1883 on the North Spit, showing that by 1883 the North Spit's dry-land tip lay north of Pigeon Point.
- "L[ow] W[ater] 1879."
- "Ext[reme] l[ow] w[water] June 23, 1883" on the sand bars south of the North Spit.

(Littlefield 1883)

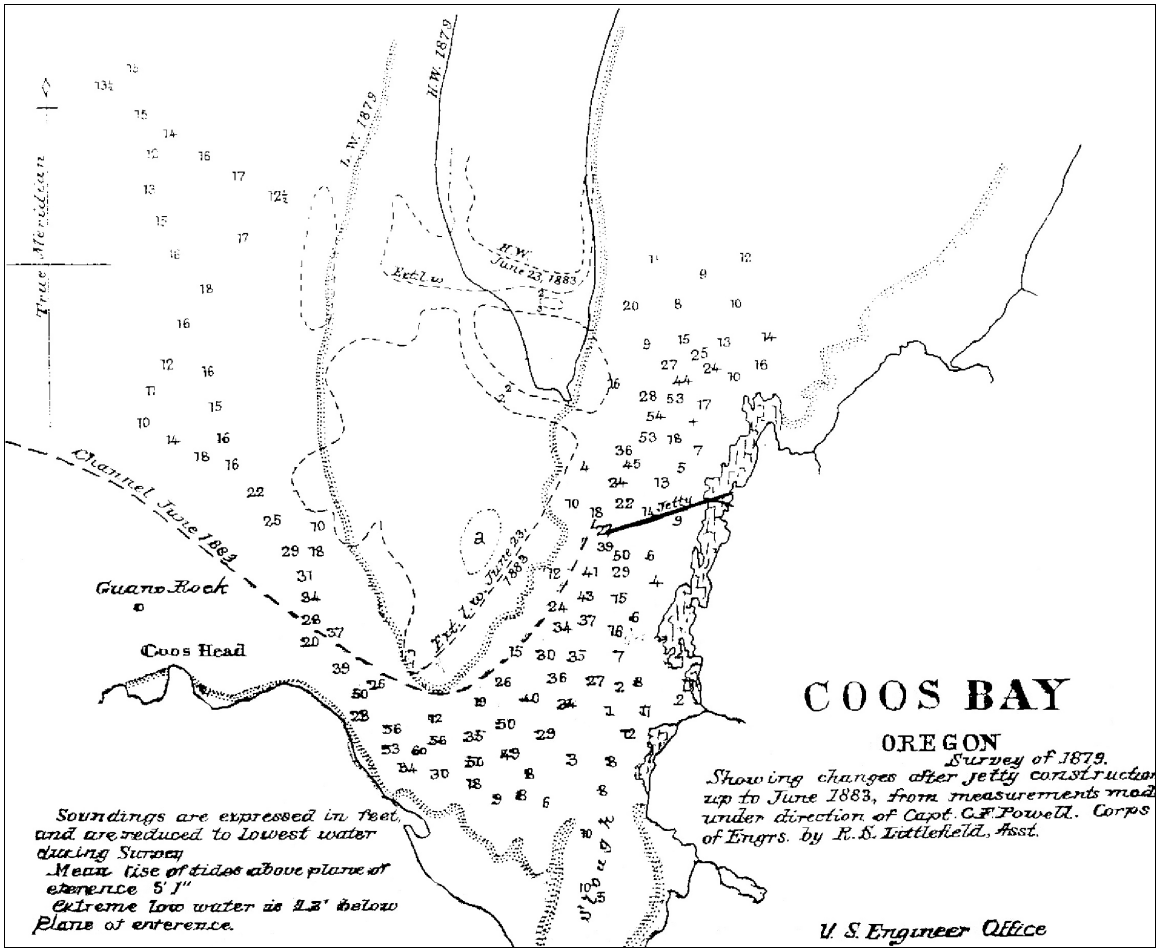

Fig. 19. Coos Bay bar, channel and lower estuary, 1883, with high and low water margins on North Spit (Littlefield 1883).

In 1885 another survey was mounted of the harbor entrance. The identity of the surveyor and the original chart have not been located. G. A. Lyell, under the direction of Captain W. Young of the Corps of Engineers, however, used the 1885 survey map for the topography when, in 1889, took new soundings and projected new jetties. Lyell's chart (Figure 20), "Entrance to Coos Bay Oregon" included the following features:

- "Projected South Jetty," extending west from Coos Head and located south of Guano Rock.
- "Projected North Jetty," extending south from the east side of the North Spit and crossing sandbars and channels to turn opposite Coos Head and run westward into the Pacific Ocean.
- "Submerged Jetty," the initial jetty laid southwesterly from Fossil Point on the east side of the lower estuary.
- Projected platforms, trestle, wharf, and buildings on the North Spit for construction of the North Jetty.
- The southernmost point of dry land (at high water) on the North Spit lying opposite Pigeon Point.

(Lyell 1889)

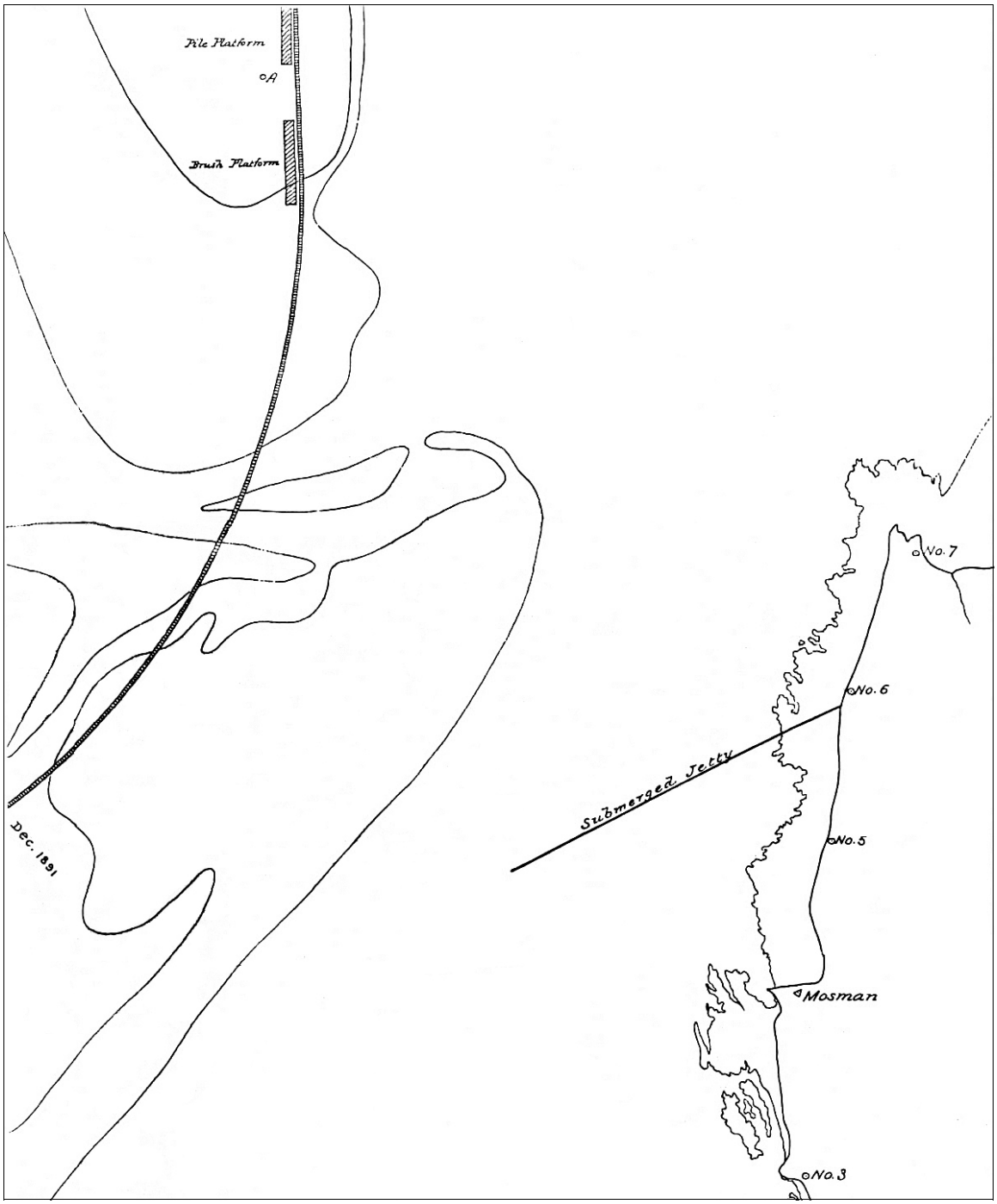

Fig. 20. Projected government works on tip of North Spit, 1889, low water margin and sandbars opposite Pigeon Point, and "Submerged Jetty" at Fossil Point (Lyell 1889).

In 1889 A. J. McMillan, under the direction of Captain W. Young of the Corps of Engineers, charted the bar and lower estuary of Coos Bay (Figures 21 and 22). McMillan based the topography--the land features--on a survey in 1885. He did not identify who mounted that survey or for which agency it was done. The depth measurements on the Young chart were all presented in feet as calculated from low water. His chart, "Entrance to Coos Bay Oregon," extended into the Pacific Ocean, passed Coos Head, and provided detailed information on the estuary at Charleston, the mouth of South Slough, and the lower bay north to below Empire City. The following features about the North Spit were shown on the chart:

- The southern tip of the North Spit at high water lay opposite or west of Pigeon Point (Figure 21).
- Sandbars bisected by channels extended south of the North Spit to a point almost due north of Charleston.
- The jetty made of rock-filled cribs extending southeasterly from Fossil Point lay at its point of origin on the east shore, approximately 1,500 feet south of the high water mark on the North Spit (Figure 22).

  (McMillan 1889)

Between March 3, 1879, and August 11, 1888, Congress appropriated $213,000 for harbor projects at Coos Bay. Except for charting of the estuary, the Corps of Engineers expended all of these sums on the largely dysfunctional jetty of rock-filled cribs extending into the lower estuary from Fossil Point. The Corps developed a new plan of improvement for the harbor entrance and, on September 19, 1890, Congress began a new round of appropriations starting with an initial $125,000 and followed on July 23, 1892, with $210,000 (Secretary of War 1893[2](4)).

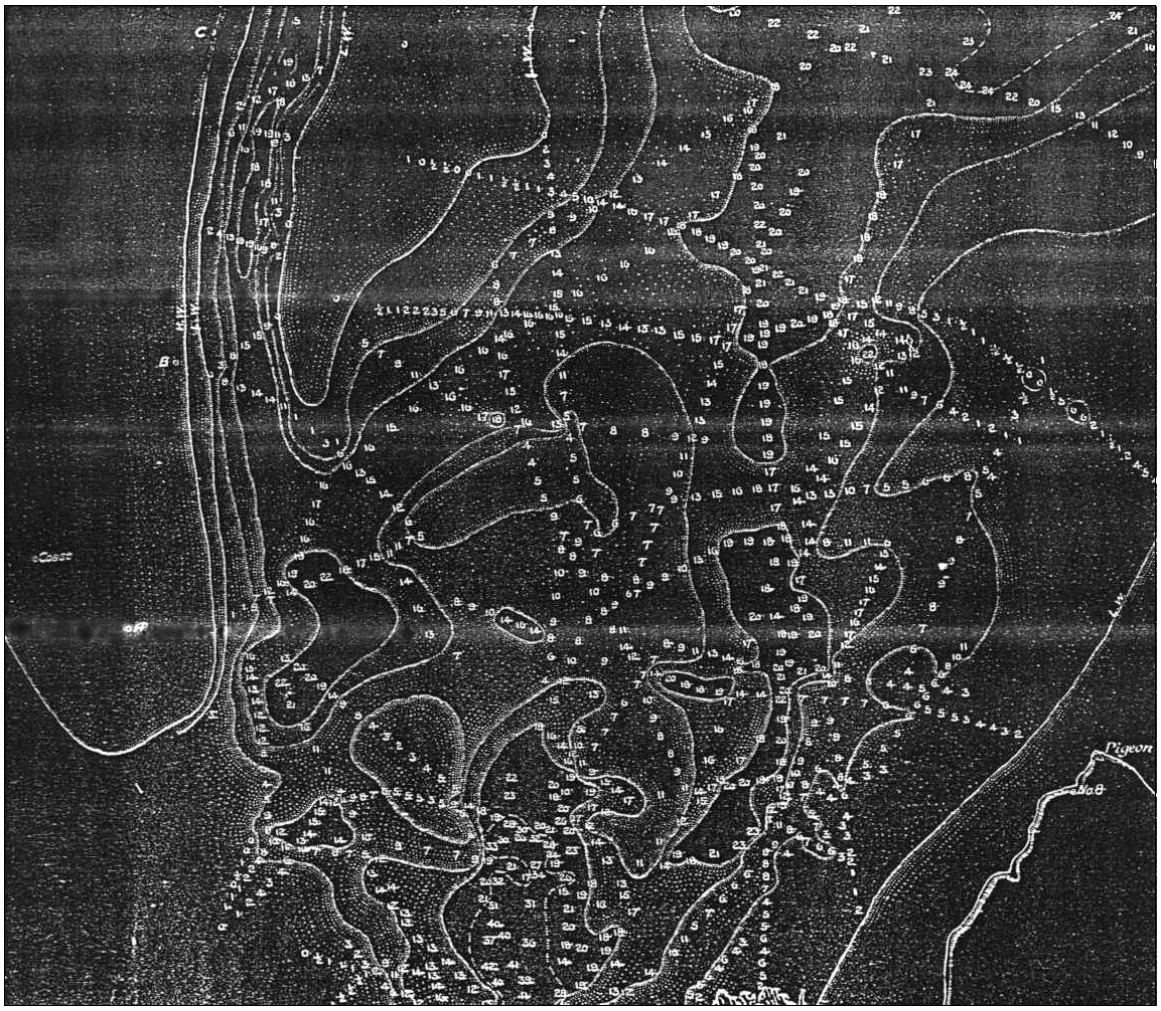

Fig. 21. Portion of chart, 1889, of lower Coos Bay showing the North Spit's high water margin (left) lying west of Pigeon Point and depth of harbor in feet (McMillan 1889).

The Corps anticipated abandonment of the jetty at Fossil Point and commencement of construction on the North Spit. R. S. Littlefield, Corps representative with oversight responsibilities for the respective projects at Coos Bay and the Coquille River in the 1880s, reported on June 15, 1889:

> My borings on North Spit were successfully made, 13th, & 14th inst[ant]s, & reported upon last date named. The spit was well above water, on extreme low waters of the two days, & no cut showed across anywhere from south end to line of high water north. As usual for June, late years, there is no swash channel above alignment of the jetty (Littlefield 1889).

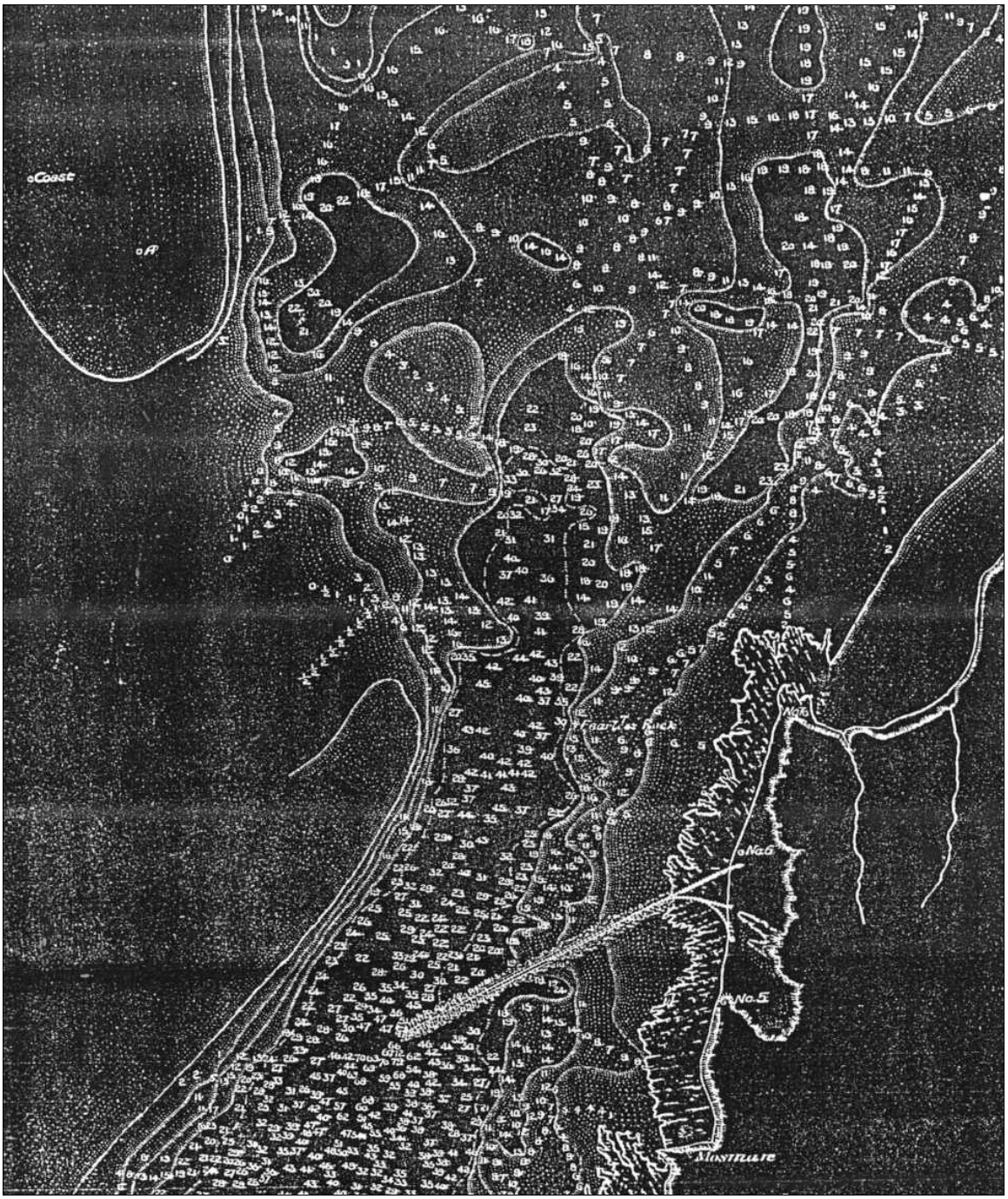

Fig. 22. Portion of chart, 1889, of lower Coos Bay showing relationship of submerged jetty (right) at Fossil Point, lying 1,500 feet south at its point of origin from the North Spit's high water margin (left) (McMillan 1889).

The Corps of Engineers had several needs on the North Spit. The Corps required a "government works" site for personnel, equipment, and materials. This location needed to be out of danger of waves, drift logs, and flooding during freshets or storm surges. Further, the Corps desperately needed to come to terms with the drifting sands and sand dunes, for the entire southern tip of the North Spit was devoid of trees and virtually without vegetation. Secretary of War Redfield Proctor addressed this matter on September 26, 1889, in a long-winded sentence in a letter to the Secretary of Interior:

> In transmitting herewith a letter of the 13th instant from Captain W[illard] Young, Corps of Engineers, stationed at Portland, Oregon stating that the Board of Engineers appointed to consider and report upon projects for the improvement of Coos Bay and Yaquina Bay, Oregon, will recommend the reclamation of the sand dunes lying to the west and north of Coos Bay between the waters of the Bay and the Pacific Ocean, and requesting that certain land in Coos County be withdrawn from settlement in order that it may be used by the U.S. for the improvement above indicated, I beg to ask whether there is any objection on the part of your Department to the withdrawal of the land described in the inclosed letter (Proctor 1889) [The enclosure letter has not survived in the files].

By October, 1889, Colonel G. H. Mendell of the Corps office in San Francisco was also concerned about sand stabilization on the North Spit. "In regard to restraint of sand," he wrote to Captain Willard Young, "I supposed that you would prefer to present a brief or synopsis of the history, methods, and circumstances of culture heretofore pursued (Mendell 1889).

Early in 1890 in an undated report, R. S. Littlefield wrote a twenty-four page letter to T. G. Owen, a lawyer and publisher of the *Coos Bay News,* about Corps projects at Coos Bay. In this account, Littlefield quoted from

the report of Colonel John M. Wilson who, in 1878, had surveyed the harbor entrance. Wilson's assessment was that the North Spit was a dynamic player in the entrance to the harbor. Its sands moved and the channel moved. Weather conditions, currents, and the configuration of Coos Head and nearby Gregory Point, location of the Cape Arago Lighthouse, were all factors in creating the challenging, uncertain bar conditions. Wilson wrote:

> The great difficulty at the entrance to Coos Bay arises from the shifting character of the sand and the peculiarities of the tides. During the summer the heavy northwest winds, sweeping down the coast, drive the sand thrown up on the shore by the currents along the North Spit, emptying it into the bay and into the channel at its entrance, thus prolonging the spit. The movement of this spit is said to be very regular, the channel breaking through to the north of its present position about once in five years. Soon after the new channel opens, the north sands again commence to move southerly. The ebb tide not being strong enough, for reasons hereafter to be given, to carry them off; this continues, the spit lengthening until it occupies the position now indicated on the chart, forcing the channel close under Coos Head, on the south side; while this is in progress, the land bar outside of Coos Head and north of 'Lone [Guano] Rock' makes northerly, caused by the fact that Cape Arago, jutting out abruptly about 2 miles to the westward, prevents to a great extent the escape of the drift sand, and the convergence of the shore-line, between the mouth of Umpqua and the entrance to Coos Bay, (The main shore-line running nearly north and south, while that of Cape Arago runs nearly east and west), concentrates the force of the northwest seas into this pocket; moreover, as the channel inside of the north spit makes down and the current strikes Coos Head, it is forced to the northward along the western side of the spit (Littlefield 1890).

Littlefield also quoted from the report of Captain A. H. Payson of the Corps on Engineers who filed his observations on January 8, 1880, about condition on the bar:

> The channel out of Coos Bay is subject to large and rapid changes. It exists to deep water in extreme positions, being

separated from 1 1/2 to 2 miles, and its main directions shifting from east and west to north and south, while its least depth has ranged from 9 to 20 feet. Theses changes are incessantly in progress, more gradual and in one direction during northeast weather; sudden and in the opposite direction during winter gales. After every period of rough weather the pilots before towing in or out are obliged to make a careful search for the existing channel, previous knowledge being entirely untrustworthy. The ruling depth will also change from 2 to 3 feet in a single storm. Under these circumstances, in spite of the service of efficient tugs, the delays to commerce are great and unavoidable, schooners having been kept waiting inside for a chance to cross for three and four months, and steamers for thirty days.

From the low point on the north, and Coos Head on the south side of the entrance, stretch two submerged sand-spits overlapping each other and defining the channel.

By the inner or north spit this is kept in a narrow and deep passage close against the rocky eastern shore of the lower bay and the cliffs just inside Coos Head.

By the outer or south spit it is there deflected sharply back in almost the opposite direction, and, running north by west along the outer face of the north spit for nearly a mile and a half, crosses the crest of the bar and comes abruptly into deep water. Though the least depth is 14 feet, it is found in a very narrow space, the distance between 3 fathom curves inside and out is more than a mile, and the direction is unfavorable with respect to wind and sea (Littlefield 1890:13-14).

Having dedicated a decade of his labors to the jetty at Fossil Point, Littlefield remained in 1890 persuaded that the project, in spite of its slow progress, had yielded results by deflecting currents away from the eastern shore to cut through the sand bars beyond the southern tip of the North Spit. "Upon the first considerable jetty construction," he wrote, "erosion of the north spit was plain. After the first winter the north bar channel had moved south about one half towards the intended position. At no time has it gone back

to the north, although it has shifted back and forth a little and changed depths somewhat" (Littlefield 1890:17-18).

Littlefield's optimism was not shared by the Corps of Engineers. The new "Plan of Improvement" for Coos Bay focused on the proposals for north and south jetties raised in 1878 by Channing M. Bolton and John M. Wilson. This plan anticipated a south jetty anchored at Coos Head and extending west into the ocean and a north jetty extending from the North Spit into the Pacific.

The letter of T. G. Owen represented only part of the pressure mounting on the Corps of Engineers to try to improve the Coos Bay harbor entrance. Shipwrecks, loss of life, increasing exports, and frustration of sawmill and mine owners all fed the interest in a safer and more efficient bar. Bynon Pengra, former surveyor-general of the General Land Office in Oregon, entered these affairs on January 9, 1890, when he told Capt. Thomas W. Symons that he was "thoroughly convinced of the ultimate and complete availability of Coos Bay as a harbor capable of being improved to a capacity sufficient for all classes of seagoing vessels." Pengra posed nine questions about the bar and projected improvements which he wanted answered. He then turned to the North Spit. In these questions Pengra, a respected public official and primary developer of the Oregon Central Military Wagon Road, pressed the Corps to Consider vegetative reclamation of the North Spit:

> 10th What is the character of the earth on what is known as the North Spit, and what is its breadth as it extends inland northward from the most southerly point of the spit opposite Coos Head to the most extreme northerly portion or bend of the bay?
>
> 11th Is any portion of the north spit for the distance last named timbered, and if so what classes of wood, and undergrowth?

12th Is it not true that a large portion of the drift which accumulates within the bay is that of light sand which, having been thrown up by the waves on the shore of the north spit is 'carried by the winds across the spit into the bay?'

13th I notice that the movements of drifting sands is in our day being successfully prevented by the planting of shrubs and timber of quick growth. One instance of the kind is that of the planting of the once sand waste, but now is known as Golden Gate park at San Francisco (See reports of Park Commissioners of 1872 & 1873).

Is it not possible that this plan could be successfully resorted to, to prevent by planting timber and shrubbery of quick growth the drifting of sand across the north spit?

14th What amount has been recommended to be appropriated for the continuing of the work of extending jetties for the season and what amount could be profitably expended in the improvement during the season?

15th If in your opinion the plan mentioned of planting timber to prevent the drifting should be tried, would it not be advisable that a sufficient appropriation should be asked of the General Government of form $5,000 to $8,000 to test its practicability?

16th And finally in what regard if any does the drift to be removed from Coos bay and the entrance thereto differ if at all from that of the entrance into and in the Columbia river, and what is the comparative amount of drift to be removed at the entrance of Coos when considered in connection with that of the entrance of the Columbia river? (Pengra 1890)

The seeds planted by Bynon Pengra eventually germinated in the thinking and actions of the Corps of Engineers.

The actions of the Corps of Engineers did not go unnoticed locally. George W. Loggie, a Canadian by birth and leading figure in the Southern Oregon Company of Empire City, was undoubtedly aware by June, 1889, of

Captain Littlefield's borings to determine the character and depth of the North Spit. Loggie was a shrewd investor. His firm had a tugboat, mercantile store, and a cavernous sawmill built adjacent to the old sawmill and shipyards of Henry H. Luse. An opportunist, Loggie traveled to Roseburg and paid cash to purchase the extreme southern tip of the North Spit. Loggie obtained "Lot numbered three of Section twenty six in Township twenty five south of Range fourteen west of Willamette Meridian in Oregon, containing twenty acres according to the official Plat of the Survey of the said lands." The patent was issued February 3, 1890 (United States of America 1890).

Loggie, by silent and swift action, had secured hold of the twenty acres lying above the high water mark as surveyed in 1857 by Harvey Gordon. The Corps of Engineers now had a problem on the North Spit. Ready to proceed with its new plan of development, it had lost the pivotal piece of property where it planned to establish the "government works" and commence building the trestle to lay rock for the north jetty. It had also lost its ability to commence reclamation of the spit by plantings, provided it embraced the recommendations of Bynon Pengra. Loggie held a trump card with the key twenty acres in his control.

The prospect of planting the North Spit became a subject of investigation of the Corps of Engineers for much of 1890. Major H. M. Adams advised Captain Thomas W. Symons on February 6 that he had solicited information from the Secretary of Agriculture "respecting the planting of grasses for protection and preservation of sand dunes" (Adams 1890). Secretary J. M. Rusk responded that the Department of Agriculture had not experimented with dune stabilization but noted: "Near our Experiment Station in Southern Kansas the sand dunes which prevail in the vicinity of the Arkansas River have been, during a few years past, very much stayed and fixed by the growth of a very strong, deep-rooted grass which, although not

itself nutrition, serves to bind the sand and give opportunity for the growth of better species." Rusk added that a stiffer and stronger species of beach grass, *Ammophila arundinacca*, had accomplished the same mission at Cape Cod and on the dikes in the Netherlands, a report of which appeared in Flint's *Grasses and Forage Plants* (Rusk 1890).

The investigations mounted by Captain Symons followed up on the recommendations of Bynon Pengra. He contacted the Office of the Commissioners of Golden Gate Park, San Francisco, California, to ascertain what steps were taken there for sand stabilization. R. P. Hammond, Jr., chairman of the commissioners, reported that park personnel had used a variety of strong-growing grasses with creeping or jointed roots "good for holding the sand." Premier among the varieties was Holland Grass, *Arundo Arenaria*. "The best way to plant it," he noted, "is to plow the roots in, say in every third furrow drop in the roots about 2 f[ee]t apart covering them with the plow. Then plow another three furrows and drop in another row of roots, and so on." On terrain too steep for a plow, Hammond recommended digging pits twelve inches deep, dropping in a few roots, covering them with sand, and pressing down firmly with the foot. He recommended plantings three feet apart. "After the grass is planted sow the ground thickly with Lupine seeds, covering the seeds with a hand rake," he added. Then, in the following year, Hammond said: "plant the whole about 4 f[ee]t apart with some hardy variety of pine (Hammond 1890).

William F. Fox of the New York Forest Commission provided further counsel on sand stabilization. He wrote to Captain R. S. Littlefield that the town of Orleans, Massachusetts, on Cape Cod had established a successful planting program, that the American Forestry Congress of September, 1885, had considered the matter, and that John Crombie Brown had written *Pine Plantations on the Sand Wastes of France*, a volume possibly available

through a secondhand or rare bookstore. Fox recommended reading George Perkins Marsh's classic volume *The Earth as Modified by Human Action*, "a very interesting and valuable work," and enumerated several magazine articles on sand hills and plantings in *Popular Science Review, Penny Magazine, American Architect,* and *Van Nostrand's Eclectic Engineering Magazine* (Fox 1890).

Symons and Littlefield by the fall of 1890 had secured valuable bibliographic information on dune stabilization. On September 18, Symons wrote to the Chief of Engineers in Washington, D.C., asking for authority to use some of the appropriations for the Coos Bay project to purchase books and pamphlets on the subject (Symons 1890). That same month Bernard Fernow, chief the Forestry Division of the Department of Agriculture, forwarded to Symons the 1872 report of the park commissioners in San Francisco on their projects. "You might find in this publication some additional notes of interest," he observed, "especially in regard to the sand soil vegetable applicable to the fixation of dunes" (Fernow 1890).

While data collection on dune stabilization proceeded, the Corps wrestled with design and location of the north jetty. Colonel G. H. Mendell, commander in the San Francisco office of the Corps, was unequivocal in his letter of February 19, 1890, that the new jetty was perceived, in part, as a device to catch sand and facilitate accretion of land. Writing to Captain Symons in Portland, he said:

> But so far as I can recall the circumstances, I think the location of the north line of stonework on the long flat, and until the jetties assume parallelism, is open to considerable latitude. This part of the north jetty is not described in the text, and the drawing is regarded rather as an indication than a prescription. The function of this part of the work is **to insure connection with the shore as a revetment to hold in place the sand that may be gathered against the work** (Mendell 1890) [Emphasis supplied].

Part of the orientation for the jetty involved pinpointing the precise location of Fearless Rock, a submerged rock in the lower estuary. In April Robert Warnock mounted a reconnaissance for the rock believed by many as the end of the rocky reef extending southeasterly from Fossil Point. Warnock located the point where the rock was marked on charts, dropped a buoy to mark it, and found the depth to be forty-two feet at low water. He constructed a floating frame from which iron rods lay horizontally twenty-four feet below the surface and hauled it back and forth through the channel but failed to find the rock. Allegedly the tug *Fearless*, a vessel with a draft of eleven feet, once grounded on the rock, giving rise to its name. "The exact point where she struck is unknown and the whole account of the accident is rather traditional," observed Warnock, "no one now living on the bay being familiar with its details." The search for Fearless Rock thus ended without confirmation of its existence (Warnock 1890).

Projects in 1891

Commencement of the North Spit projects began in December, 1890, with the arrival of James S. Polhemus on Coos Bay as the Corps project manager. Polhemus had a terrifying transit into the harbor. A large wave hit the *General Wright*, the vessel on which he had taken passage, and swept the decks of cargo. Some $600 worth of furniture and office supplies washed into the sea (Polhemus 1890a).

One of Polhemus' first assignments was to meet with George Loggie to discuss the ownership of the southern tip of the North Spit. On December 17, he reported:

> I went to see Mr. Loggie the day after you [Capt. Thomas W. Symons] left, and asked him if he had thought the matter over and was ready to put a price on his land on the spit. For a

> good while he was not inclined to name any figure, but finally told me he would take $500.00 for it.
>
> I think it would cost the government that much with what he would probably be awarded, should the land be condemned.
>
> Judge [Lewis Linn] McArthur who conducted the two Yaquina cases for the government would know just what they cost, and probably this case would cost more if we have to pay the traveling expenses of all the witnesses, then juries are apt to be liberal to the individual as against the government, and of course he would pick witnesses who would look at it in his light.
>
> It would be desirable for us to have control of the whole point to keep away saloons or any interference with our work (Polhemus 1890b).

While working on Loggie to secure a sales agreement on the tip of the North Spit, Polhemus selected a site at Yarrow (subsequently called North Bend) to build a wharf, small warehouse, and booms for holding between 1,000 and 1,200 piling. He needed a site protected from the prevailing winds and suitable for construction of scows for hauling rock to the jetty. "The location is central & convenient," he wrote, "and we would always have a place to haul out and repair our scows which will be necessary nearly every season during the continuance of work" (Polhemus 1890c, 1890d).

Polhemus also laid plans for the "government works" on the North Spit. He sketched a facility (Figure 23) which included a wharf (200' x 50') with two derricks for lifting jetty rock off scows, an office, warehouse, carpenter shop, turntable for the locomotive and railcars, pile driver turnout, and a variety of trestles. By placing all of these facilities high above the southern tip of the spit on piling, Polhemus believed "the buildings and appliances would be safe thereon **in times of storms when the sand spit is covered by water and drift**" [Emphasis supplied]. In this same letter Polhemus further noted: "I asked

Mr. Loggie to state in writing his proposition to sell his lands for 500^{00} which he said he would do (Polhemus 1890e).

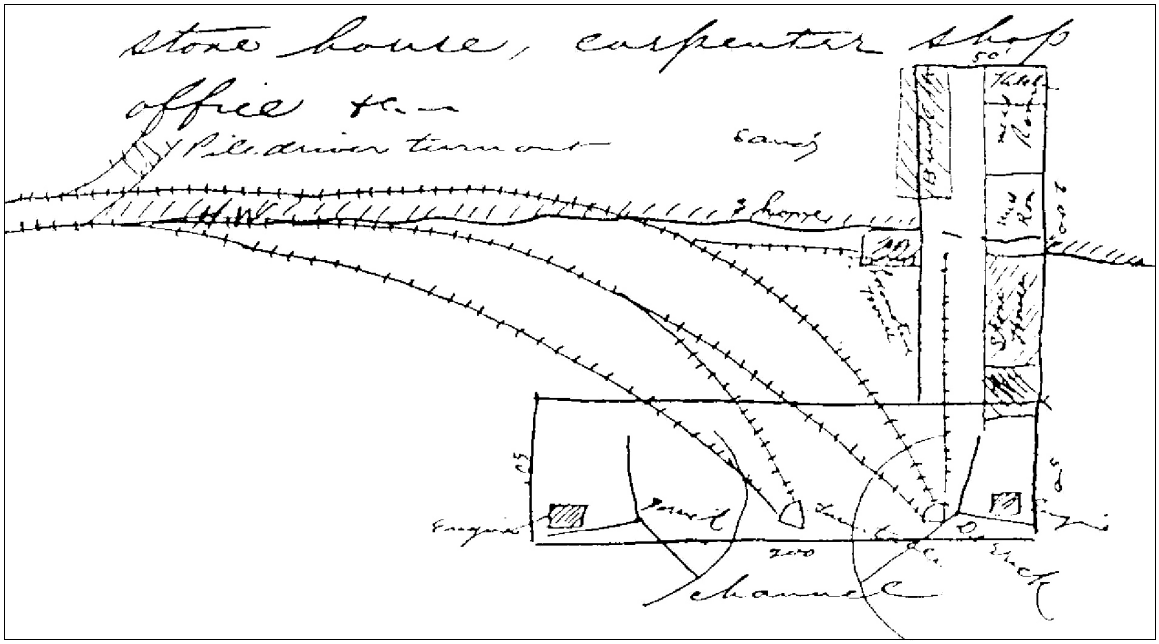

Fig. 23. Draft plan of the Corps's "Government Works" on the "sandy shore" adjacent to the "channel" on the North Spit (Polhemus 1890e).

On December 20 the Engineer Department of the Corps's Portland office received authority "to purchase from Geo[rge] W. Loggie, 20 acres of land at the extreme south point of Coos Bay Spit, for $500, to erect buildings &c. upon in connection with imp[rovemen]t of Coos Bay." On December 30 Brigadier General Thomas Lincoln Casey endorsed the purchase (Casey 1890).

B. W. DeConvey worked on designs for the anticipated north jetty. After studying currents and the potential flushing actions of the bay, DeConvey concluded that a curved jetty would work best to form a channel with a width of 400 feet and take advantage of wave and water action. Of particular concern was the amount of rock it would take to

establish a jetty foundation, how the foundation would withstand erosion, and how, in time, it would foster the accretion of land. DeConvey wrote:

> At first without doubt the settlement of the foundation will be large, but when the settlement has adjusted itself to all the forces at work, I think the erosion action will reach a minimum in the current trace in a shorter distance, than in the straight line; that is, the resistance to the wave action will be gradual, and, consequently of less damage.
>
> Ample allowance in my opinion has been made for this settlement, in the estimate (22 per c[en]t) and also a brush foundation has been adopted, although not shown in detail. There is no doubt of the effect of a current concentrated, on a bar, of sand or gravel by an arrangement of straight jetties, but the curved trace also, gradually--concentrates and produces the same effect. From the indications in this place I should consider it not very far to rock (DeConvey 1890).

Acquisition of the George W. Loggie property remained a top agenda item for the Corps of Engineers. James Polhemus addressed the matter again on January 6, 1891:

> I spoke to Mr. Loggie twice about making his proposition to sell his piece of land on the sand point for $500.^{00}$, in writing: so that there might be no misunderstanding about it after you had secured the necessary authority from Washington. He said he would do so, but I rather doubt if he will, unless in reply from a letter from you. He said "You need not be afraid about his gong back on the price," but I would suggest you write him (if he has not already stated his price to you), and draw from him the statement" (Polhemus 1891a).

The worries of George Loggie's price on the land diminished when on January 11 James Polhemus secured verbal assurance that Loggie "would make the deed out at once & forward [it]" (Polhemus 1891b). On January 16 Loggie turned over to Polhemus the deed to the critical twenty acres at the southern tip of the North Spit. Polhemus was explicit about the location of

the land: "Mr. Loggie handed me the inclosed deed & patent to his land **at the point**, which I have the honor to forward forthwith" (Polhemus 1891c).

Resolution of the Loggie land acquisition took time. On February 17 Polhemus reported: "I left the deed, & vouchers at Mr. Loggie's office to be signed when he returns, probably in a week. I has been away about ten days." Polhemus had secured certification from the Coos County clerk's office that there were no mortgages or liens against the property (Polhemus 1891d). On February 20, J. J. Lamb, the clerk, issued the certification that he found no liens of any kind nor any conveyances of any part of the twenty acres by Loggie to another party nor any pending lawsuits or actions which could affect the title (Lamb 1891). On February 25, Franklin P. Mays, U.S. Attorney for Oregon, reported that he had received the abstract of title, that Loggie held the land "vested in fee," and that it was "free from all incumbrance." He wrote: "When the deed, which I sent you, is executed, the government can thereby obtain good title to the land, provided of course no rights shall intervene between the date of the abstract and the date when your deed is filed for record" (Mays 1891). On March 7, Loggie signed a Corps voucher for $500 and surrendered his deed (Polhemus 1891e). On April 8, Polhemus put closure on the federal government's purchase of the Loggie tract: "I have the honor to return herewith deed from G. W. Loggie to the United States, which I have had put on record inclosed please find Mr. Lamb's (County Clerk's) bill of $1.[25] and signing vouchers for recording" (Polhemus 1891f).

George W. Loggie succeeded brilliantly in his real estate deal on the North Spit. By making a quiet trip to Roseburg and paying $25.00 in a cash entry transaction, he obtained early in 1890 clear title to the twenty acres at the southern tip of the North Spit. The land was, for the most part, above high water except in storms when it, too, was washed by waves and

covered with drift. What to some may have appeared as a worthless investment brought him a twenty-fold return in twelve months. By cooperating with the Corps of Engineers, Loggie also opened the prospect that he would receive consideration for rental of his steam tugboat, opportunity to sell piling, and purchase of groceries and other supplies at his store in Empire City to maintain the laborers residing at the "Government Works" during the years of building the new jetty. As it soon turned out, Loggie's cooperative ways also led to the contract he shared with his brother, Peter Loggie, to construct the new U.S. Life-Saving Service complex on the North Spit a half mile north of the "Government Works." Loggie's brief land ownership on the sandy spit had played out handsomely.

In the years 1891-93 the Corps of Engineers devoted major energies to what it deemed the "reclamation" of the North Spit. Its program, prompted by the inquiries of Bynon Pengra and shaped by receipt of information about sand stabilization programs in California, Kansas, Massachusetts, and Europe, commenced in 1891. In February the Corps of Engineers ordered rooted plants of *Arenaria Arunda*, or "sea grass," for shipment in small lots to insure appropriate care and handling for the North Spit project (Love 1891). On March 2, Colonel G. H. Mendell, commander of Division Office in San Francisco, emphasized the significance of this project: "The reclamation of the great sand dunes on North Spit at Coos Bay is regarded as an important feature of the harbor improvement. The method proposed has been very successful here [at San Francisco], and it is recommended that it be tried at Coos Bay" (Mendell 1891a).

By mid-April crews at Golden Gate Park were digging "Holland Grass," another name for the *Arenaria Arunda*, for shipment to Coos Bay on the steamer *Arago* (Mendell 1891b). On April 24 Colonel Mendell shipped thirty sacks of grass to James Polhemus at Empire City, noting "the quantity is

perhaps sufficient for all the planting you will desire to make and no other shipments will be made unless requested by you." The grass was free but freight and handling charges ran to $18.50 (Mendell 1891c). On May 31 Polhemus reported that the thirty sacks of grass arrived in late April. The laborers planted it immediately "in the sands of the North Spit. "I notice that not over half of the grass appears to have started," he noted, "but some has grown over a foot, the weather has been damp & quite favorable for it" (Polhemus 1891g). In a report dated May 1, Polhemus stated the grass had been "planted in the sands at North Spit in three places." "We planted the roots about 1 foot deep in holes 2 1/2 to 3 feet apart and selected what seemed to be the most favorable places to insure the growth and propagation of the grass." The plantings covered about three acres (Polhemus 1891h).

The North Spit proved a daunting workplace. It was frequently lashed with storms: wind, waves, and rain scoured across the exposed, low shoreline. "The North Spit is a hard place to work some days even when clear we have howling North Westers that blow the sand so that one can hardly see, and it is difficult to pick up even a board," wrote James Polhemus on May 9 (Polhemus 1891i). Captain Thomas Symons remained concerned about the stabilization program. On September 18, for example, he wrote: "Among other plants, other than those we talked about for cultivation on the Coos Spit, it occurred to me when going over to the Coquille, that Killikinick would be a good plant to cultivate." Symons found large expanses of Kinnickinick growing along the route of his travels to the mouth of the Coquille River. "A man could in a short time gather a large quantity of these berries," he observed and urged experimentation with these plantings in the dunes (Symons 1891a).

On September 21, Captain Symons wrote to the President of Oregon Agricultural College in Corvallis:

> An effort is being made to reclaim the sand spit at Coos Bay by the cultivation of plant growth upon it, and thereby stopping the drifting sands. On a recent visit there, I found among other plants, two species of grass, and one other plant which appears well suited for this purpose. I send you specimens of these grasses, and of the plant in question, with request that you furnish me with all possible information in regard thereto, particularly as to whether it is possible to get seeds of the grass in any quantity for planting (S[ymons] 1891b).

Colonel G. H. Mendell monitored the Coos Bay North Spit reclamation project closely. On September 26 he wrote to Captain Symons that he considered it fortunate that 30% of the plantings set out on the spit had survived. "This grass must prove a valuable addition to the sand flora," he wrote, "for the reason that it thrives best when supplied with new sand." He was also concerned about the predation of cattle on the North Spit entering the planted areas and disturbing the Holland Grass. "Can you shut off cattle by a wire fence at moderate cost," he asked (Mendell 1891d). Captain Symons immediately wrote to James Polhemus at Empire City: "What about the cows on the sand land, and the property not in the hands of Government? Does the Life Saving man keep his cows off the grass?" (S[ymons] 1891c).

The Corps of Engineers continued to investigate other plants to capture and build up sand on the North Spit. On October 8, Captain Symons inquired of a nursery firm in San Francisco if it had the seeds of *Elymus arenarius* and *Ammophila arundinacea*. "In a letter from the Secretary of Agriculture," Symons observed, "he states that the seeds of this grass [*Ammophila arundinacea*] are sometimes imported from Europe, where it is used on the banks of dykes and levees to hold the soil" (S[ymons]

1891d). The year 1891 marked the beginning of major reclamation efforts on the North Spit. The Corps of Engineers had investigated a variety of plant materials, imported Holland Grass, and began plantings to stabilize sand. It coped with the loss of two-thirds of the imported plants and hungry cows, but the process of building up the North Spit was firmly underway.

Throughout 1891 James Polhemus initiated a variety of other projects: the search for a source of rock at a quarry on Coos River, building of facilities and construction of scows at Yarrow on the upper bay, disassembly of buildings and salvage of materials at the initial jetty site at Fossil Point for removal to the North Spit, location and design of the North Spit facilities, construction of the "Government Works" on the North Spit, and commencement of building railroad trestles for the north jetty.

One of the initial concerns facing Polhemus was where to locate the "Government Works" on the North Spit. The initial site, indicated "A" on a map no longer extant, was at the southern point of land at high water. But, with the passage of time, land accretion had extended considerably south of point "A." Polhemus thus became worried about that site's stability, especially if washing action produced by the new jetty should reconfigure the spit. He thus arrived at another alternative. On February 13 he wrote:

> I have thought of a plan of putting the wharf at the point marked "C" on the sketch, some 1500 feet to the north [of Point A], up the channel; and then running the approach down in a Southerly direction until it turns into the line of the North jetty as shown by the broken line, thus holding that much of the spit and perhaps maintaining a permanent channel & wharf site which would be such a decided advantage.
>
> Of course this location would necessitate an expense of $5000 or $6000 over that at A for the additional length of tramway approach.

> It is something worthy of careful consideration and I would request you to give me some instructions about it.
>
> I am inclined to think the location marked C would be the safest & best as it probably would insure a permanent wharf site throughout the continuance of the work.
>
> It will also be nearer a more permanent supply of fresh water (Polhemus 1891j).

Subsequent maps and photographs confirm that Polhemus located the "Government Works" at point "C," a distance about 1,500 feet up the North Spit to secure a firm site for the trestles, wharf, buildings, and well for fresh water. The long trestle running south before turning westward to create the north jetty documented his decision.

The months of February and March, 1891, were primarily consumed with gathering supplies. Polhemus ordered a variety of materials: a flag, steam whistle, foodstuffs, chains, paint, varnish, lead, lumber, coal, piling, spars, track, and a switching locomotive, the "Yarrow," of 22,000 pounds purchased for $3,250 from the Baldwin Locomotive Works in Philadelphia (Polhemus 1891k).

By May 1 the "Government Works" had taken on shape. Workmen had finished the wharf set on piling. They also constructed an approach from the wharf to the high water mark; this structure measured 50 by 110 feet. They set special piling to house a self-registering tide gauge, set and rigged a derrick, installed a Ledgerwood hoisting engine, and built a house 20 by 36 feet to enclose it. The men framed another building, 20 x 100 feet, to house the locomotive, carpenter shop, and blacksmith shop. They set piling for buildings for bunking and eating quarters for the crews, built a platform to hold 80 tons of rails, and dug a well to secure fresh water. At Yarrow the

workmen were engaged in constructing scows to haul stone from the quarry on Coos River (Polhemus 1891h).

In May attention focused on two quarries on Coos River: one known as the "Government Quarry" and another on a farm owned by the Noah family (Polhemus 1891l). George Loggie hovered over the projects and sought opportunity at every turn. On May 11, T. S. Minott of Marshfield reported to Captain Symons:

> I have received information indirectly that G. W. Loggie is protesting in Washington against S. K. Bradford's bid on rock from Gov[ernment] Quarry stating that it did not arrive untill day after bids were advertised to be opened. He is doing all he can no doubt to knock out Bradford's bid, and get it himself and using all means for that purpose.
>
> It seems impossible for him to act the man in any case and never is thoroughly at home unless he can employ foul means to gain his ends (Minott 1891).

James Polhemus found it expedient to try to work with Loggie. He took Loggie to examine the quarries and agreed on May 14 to hire Loggie's tug. Polhemus said: "it is a reasonable offer, and will relieve us from a good deal of trouble, as it is going to take about all of one boat's time to two from that quarry when we get running full force" (Polhemus 1891m, 1891n). Polhemus also contracted with Loggie to provide poles at $.22 each for weaving with brush at $2.00/cord for the manufacture of fascines--brush mattresses to hold the jetty rock as it was dumped onto the sand. On May 31 Polhemus purchased of George W. Loggie $1,090.34 worth of groceries and lumber for the "U.S. Government Coos Bay Improvement" (Loggie 1891).

In May and June heavy equipment arrived via coastal steamers. The Corps moved the pile driver from its project at the mouth of the Columbia River and shipped it to Coos Bay. On June 13 the locomotive "Yarrow"

arrived on the *Emily* and the *Wilmington* brought in four flatcars and four, geared dump cars (Polhemus 1891o).

In August the crews began laying brush fascines. The first shipment arrived at the Government Works on August 22 as did 300 poles from George Loggie's workmen. "We are more than half way across the swash channel at the North Point," reported Polhemus as he described the southward advance of the trestle (Polhemus 1891p). The "swash channel" became a subject of discussion when J. R. Savage reported on August 22 to the Corps of Engineers on his reconnaissance of the Coos Bay bar between July 31 and August 20:

> The High and Low Water Lines on the sand spit as shown on the map were all located on the ground as were also the Government Wharf, tramway, buildings, etc., but the main part of the High and Low Water Lines on the East and South shore I propose to take from the Coast Survey Chart of 1889 as the difference, if any, between the present shore line and that of two years ago will be hardly perceptible. At the time of the survey the tramway leading to the North Jetty was completed as far as the High Water Line so it is safe to assume that part at least of the change that is henceforth shown will be due to the effects of the Jetty. I made a survey as far as possible of the blind channel running out past the End of the tramway as at present completed, as I thought it would be interesting to know the depth of the same and in this way gain an idea of the amount of water passing through this channel. This depth on the average is somewhere between four and six feet at low water with a strong current when the tide is running.
>
> The bar is now probably in as poor condition as it ever was, at mean high water the best channel over the bar affording only about 15 feet. In consequence of the shoalness of the water and of the exposure of the bar there is at nearly all times a heavy swell running on the crest of the bar which generally prevented us from working more than 3 hours per day on the bar and then only near high water, the swell being less troublesome at that time.

> The crest of this bar is probably the furtherest out of any on this coast south of the Columbia River being over a mile distant from the entrance proper at Coos Head and my impression as gathered form the soundings as they were taken, is that there is not much difference in the depth of water all along the crest of the bar though I think the map will show a middle ground or shoal spot about in the centre of the bar. The passage from Coos Head to the bar is a narrow one averaging about 1000 or 1200 feet in width and is very well defined by the breakers on the north and South Spits and as this channel approaches the bar it spreads out in the shape of a fan and once you cross the bar the water deepens rapidly to 35 and 40 feet (Savage 1891).

By the end of October, Captain Symons reported considerable progress on the Coos Bay harbor improvements. The workers, numbering about thirty a month on the North Spit, had constructed 303 bents and built 4,800 feet of trestle before terminating pile driving on October 2 for the winter. The trestle extended 1,664 feet beyond the low water mark. The men had laid down 2,448 feet of brush fascines and weighted them with rock. This labor began to pay off when they set a second center mattress of fascines on top of the first for a distance of 195 feet "where the jetty crossed the low water mark." This bulwark caused the "sands to collect and fill up and advance the high water mark seawards," noted Symons. In October the quarry shipped thirteen scowloads or 3,035 tons of rock which the workmen dumped between the tracks onto the mattresses, especially on the 1,700 feet of trestle and jetty beyond the low water mark (Symons 1891e).

Although trestle work suspended in early October because of adverse weather conditions, workmen continued to lay fascines and dump rock through November and December. Several of the projects were stop-gap activities to place fascines and rock to thwart efforts of the current to cut

through the low jetty by scouring out holes. Both high tides and heavy seas took a toll on the work accomplished (Symons 1891f).

Projects in 1892

In 1892 the Corps of Engineers resumed its efforts to stabilize the sands on the North Spit and hasten the accretion of land. The commitment of James Polhemus led him in January, 1892, to write a summary of the "Reclamation of Sand Dunes." The report illustrated the planning and determination of the Corps to foster the accretion of land on the entire portion of the spit--from Lots 4, 5 and 6 of Section 24--southward (See Figure 3). Polhemus wrote:

> On account of the magnitude of the undertaking and the small amount of the appropriation ($125,000) very little was attempted in the way of reclaiming the sandy wastes of the North Spit, except in setting out grass roots, and gathering some seeds.
>
> Only a small portion of the 30 sacks of Holland Grass roots which were sent from Golden Gate Park S[an] F[rancisco] last April took root and grew.
>
> During the Autumn and early Winter a few bushels of seeds were gathered from the native plants of the Spit, principally from two kinds most plentiful and growing and spreading naturally in the moist barren sands. One is a vine [kinnickinick] with a large branching root and sticky leaves. It bears clusters of small fragrant yellow flowers. The other is a low growing annual found growing luxuriantly in the most exposed situations. About 30 bushels of cones from the marine pine, and spruce, which grow naturally in the sands close to the beach were gathered for seed.
>
> The Holland grass was set out in different localities with a view of seeing how it would thrive in this locality and of securing if possible some propagating plantations. When started it seems to do well, but here needs some protection at first to establish it.

During last fall and the present Winter the weather along the coast has been unusually boisterous, and during the most violent gales the higher sand dunes are often cut down from 2 to 6 feet, and long banners of flying sand can be seen trailing to leeward of their crests, which covers the surrounding land as it falls.

I think it would be useless to attempt the reclamation of the sand spit except in a most systematic and continuous manner with a sufficiency of funds available to take in at least a moderately large area each year. For the first attempt I would suggest all that portion of the spit to the south of the boundary between lots 5 & 6 of Section 24, which with lot 4 belonging to the U.S. Life Saving Service and which is partially timbered is equal to about 230 acres. The timber growing on lot 4 is marine pine, spruce and hemlock. I would outline a general plan about as follows:

First to build a fence on the north boundary of the tract to be reclaimed, from ocean to Bay, which would serve the double purpose of keeping all stock (cattle) off, and of arresting the movement of sands from the north during the prevalence of the summer winds. I would build a palisade along the beach side about 500 feet from high water mark to catch and raise into a ridge the sands washed and blown up continually from the beach. The shape & size of this ridge could be regulated. It might be found advisable to build some other cheap palisades along the other lines.

Early in the Spring, or even in the Winter, I would sow the area indicated with such seeds as appeared most adapted and could be obtained readily in sufficient quantities. I believe oats would be a good base, mixed with various kinds of grass seed, scotch broom, lupin, native plants, and seeds of the marine pine, and spruce. After planting I would cover all with a protection of brush.

On some portions little would be required, but on the higher hills of light particles a thicker and more carefully placed coat would be required. In addition, to hasten the work, I would set out Holland grass, and native grass roots and transplant several thousand young pine and spruce trees, which can be

> readily obtain on the opposite shore. I would employ a good force of men and teams and push the work on the portion undertaken.
>
> There should be a watchman and two or more assistants continually employed to resow and patch spots needing repair. The moisture lies very close to the surface of the sand at all seasons, and all the plants growing in the vicinity will flourish if only protected from the force of the wind until a start is made.
>
> I can think of no better seed to sow than that of the native grasses, of which two hardy varieties grow very plentiful on the point, but it would probably be difficult to secure enough. I believe it would cost about $40.^{00}$ per acre to permanently reclaim the whole spit, which would be about $9,000.^{00}$ for the piece of land I have named (Polhemus 1892a:15-21).

In early 1892 Polhemus proceeded to carry out parts of his reclamation plan. In March workers planted 80 bushels of oats, barley, and grass seed. Polhemus reported: "Some posts for fence across [the] S[pit] were split from cedar drift logs" (Polhemus 1892b). By the end of March the men had set out 400 marine pine and spruce trees transplanted from the vicinity of Empire City. They also had set half of the 280 cedar posts for the fence and had begun planting willow shoots (Polhemus 1892c). In April they received 100 sacks of grass which they planted on the spit. This was triple the amount planted in 1891. To protect the plantings from cattle they completed a wire fence across the southern portion of the spit. Polhemus then secured a shipment of Scotch Broom seed from Fort Stevens and this was planted in early spring. The extent of commitment to vegetative transformation of the spit was confirmed in fiscal report of the Corps in June, 1892:

> There was also gathered a large quantity of seeds of plants growing naturally about the locality. These consisted of marine pine cones, killikinick berries, salal berries, and other plants, the names of which are not known. These were all planted, both as

> mixtures and separately. The knowledge gained by these experiments will be valuable in the further prosecution of the work of the reclamation of the sand flats (U.S. Army Chief of Engineers 1892[2](3):2671).

The positioning of the jetties remained a concern of the Corps during the construction phases of the North Jetty in the first half of 1892. On April 3, James Polhemus reported his observations on bar conditions and his reconnaissance of waves approaching the bar from hours of observation at Yoakam Point south of Coos Head. Polhemus laid out his vision of the engineered harbor entrance:

> As the bar channel is made to assume a direction about westerly from Guano rock, its axis will lie in that position where formerly the best bar crossings were obtained; and it would also be approximately normal to the breakers. The nearer to the Cape the location of the channel the greater would be the protection afforded during southerly storms.
>
> In general, I would locate the jetties as near as possible normal to the seas and to the curves of permanent depth as that condition is easier on the structures themselves, and would afford the greatest advantage to navigation. In that position the outflowing ebb currents would be directed in the line of least resistance directly across the bar, and more easily affect and maintain a deep channel.
>
> At the same time I would seek all the protection to be obtained from the Cape on the South, without crowding the space between the South Jetty and the shore of the bight. To meet all of these requirements as nearly as possible I should locate the jetties as indicated on the accompanying plat, viz with their seaward extensions making an angle of about 70° with the true meridian, or in the direction about magnetic West, the distance of 1500 ft. between their extremities being preserved.
>
> This location differs but slightly from that chosen by the Board of U.S. Engineers. It throws the opening about 500 ft. to the South and shifts the direction 10° to the South (Polhemus 1892d).

The location of the Coos Bay channel entrance remained a concern for the Corps of Engineers throughout the North Jetty project of the 1890s. Between August 23, 1891 and April 7, 1892, the workmen had received and placed 23,923 tons of rock from the Coos River quarries--some 100 scow loads. Nevertheless the channel remained problematic. "Our jetty at Coos is in excellent shape," wrote James Polhemus on April 7, 1892; "the rock is up to ordinary high water all the way out, but I anticipate some trouble from the bay channel encroaching and undermining the tramway just beyond the signal "North Spit." He continued: "We have dumped considerable stone at this point, but the channel is crowding over all the time (24 deep at low water); and next year it is likely we may have to repair the tramway by redriving piles for about 200 feet" (Polhemus 1892e).

The Corps projects closed down in April with the end of congressional funding. Polhemus dismissed workers, stored scows at Yarrow, and battened down the buildings at the "Government Works" (Polhemus 1892e). In his monthly report, however, he confirmed the steady progress on dune reclamation: "Four acres of the North Spit were planted with Holland grass roots, and 4 or 5 acres with marine pine seed. A barbed wire fence 1/2 mile long was built across the spit to protect these tracts" (Polhemus 1892f).

The goal of the Corps of Engineers to create a primary channel on the bar and eliminate the secondary channel and shoals south of the North Spit (in Lot 3a, Section 26, T25S, R14W, W.M.) appeared to be working. On May 28, Captain Thomas W. Symons wrote to Jonathan Bourne, a prominent Oregon attorney and industrialist:

> This extension to the north jetty has had a very marked effect in deepening the water upon the bar at the entrance as can very readily be seen by a comparison of the two charts: the one showing a depth of but from 9 to 10 feet at mean low water, and the second a minimum of 18 feet at mean low water.

Symons concluded: "The marked effect of the work is due to the shutting off by the jetty, of the secondary channel which passes out just at the end of the north spit" (Symons 1892a).

By the end of the fiscal year in June, 1892, the Corps projects on the North Spit were well positioned. Workmen had erected the wharf, shops, and residential quarters. Both a hoisting engine and a wharf derrick enabled them to move materials to work sites. They had off-loaded the eleven-ton Baldwin locomotive to haul rock and timbers on the trestles. They had received and reassembled the revolving jetty pile-driver from the mouth of the Columbia River. They had constructed 1,600 feet of the tramway south from the receiving wharf in Lot 6. Thirty to forty men had worked on the North Spit (Polhemus 1892g).

The stabilization projects beneath the tramway or trestle were founded on brush fascines twenty-feet wide. "The mattress is laid and the rock dumped," wrote James Polhemus, "from a double track pile trestle tramway constructed in advance by an overhang revolving pile driver." He continued:

> The track runs level from the wharf, and the elevation of top of rail is 21.1/4 feet above the plane of mean low water. The tramway was extended by means of the large jetty pile driver with its 10" x 6" x 10" Worthington steam pump, and water jets. It is the same driver with which the greater part of the jetty tramway at the mouth of the Columbia River was built . . . . The piles used were of fir from 45 to 26 ft. long and about 17" in. diameter at butt and cost 4 1/2 cents per foot. They were pumped into the sand from 30 to 37 feet (Polhemus 1892g).

Polhemus described the brush mattress work in detail because it was so critical to stabilization of sand around the base of the tramway and the new jetty:

> A center brush mattress 20 feet wide and 3 feet thick was placed on the sand about the piles, from bent 103 to the sea

end, a distance of 3,200 feet. Where it could not be built directly on the sand, it was made on a grillage of poles suspended by ropes fastened to iron hooks from the tramway, and lowered into place, and quickly sunk by a few car loads of the small sized rock.

The mats are made by binding with rope or wire three courses of brush fascines 20 feet long by about 1 ft. in diameter between grillages of fir poles crossed every four feet, the latter being 7 inches in diameter at butt and 24 feet long. The fascines were of fir, cedar, or hemlock brush; choked and bound with 4 ties of 3 ply bale rope. Old rope and No. 12 annealed wire were used for the main lashings.

The poles and fascines were mostly obtained by contract. The poles from Mr. G. W. Loggie at 22 cents apiece on scow at Catching slough. It cost 7 cents apiece to deliver them at the works, and about 3 cents apiece more to unload and store them. We receive din all 2,353 poles and have about 100 left on hand. Mr. Patrick O'Neil had the brush contract at $3.00 per cord on scows at various points in the Bay, which we had to tow to the works; and he furnished 1,157 cords . . . .

In addition to the regular center mat laid throughout the outer 3,200 ft. of jetty a double mat was placed for 160 feet between bents 100 and 110, where the jetty crossed the deepest part of the wash channel. Side mats were place on the west of the jetty for 364 feet and on the east, or the bay side, between bents 66 and 103 a distance of 592 feet (Polhemus 1892g).

Projects in 1893-94

Between July, 1892--when work resumed after a two month hiatus--and June, 1893, the North Jetty grew 4,432 feet to a total length of 9,280 feet from its terminus at the wharf. Of this length, 6,800 feet were covered with side mattresses and 4,112 feet with center mattresses of brush. The stabilization project consumed 3,156 cords of brush fascines and 6,207 poles, anchored with 46,000 tons of rock. The Corps report stated: "The construction of the jetty has brought about the impounding of vast amount of sand. The

high-water line has advanced along the jetty about 1,500 feet (U.S. Army Corps of Engineers 1893[2](4):3333).

The project was threatened when the currents in the bay began to attempt to reopen the old channel south of the North Spit as configured prior to the North Jetty project. The Corps project report for June, 1893, noted the corrective actions taken:

> A plat is sent herewith which shows the extension of the work up to date. A glance at this plat will show how the tramway a short distance from the wharf was threatened by the bay-channel currents. Shortly after the tramway was built the currents began to cut into the spit between bents 65 and 115, and this continued until it became necessary to protect the beach to prevent serious injury to the tramway. Brush and stone were dumped along the beach for a distance of about a thousand feet, and the encroachment still continuing it was deemed advisable to build from the tramway into the channel two short groins about 150 feet long. Piles for building these groins were driven by a floating pile-driver, and a brush mattress 5 feet thick and 20 feet wide was laid and secured by rock. The enrockment of the groin nearest the wharf was brought up to half tide; in case of the second groin, only sufficient rock was put in to secure the mattress. The groins appear to answer all requirements, as the scouring action has ceased (U.S. Army Corps of Engineers 1893[2](4):3335-3336).

The dune reclamation project suffered setbacks in the 1892-93 fiscal year. Many of the shore pines and spruce trees transplanted from Empire City toppled over the violent winds raking the spit. The willow cuttings budded and commenced to grow but their future remained uncertain. "The Holland grass (*Arundo arenaria*)," wrote James Polhemus, "from Golden Gate Park, San Francisco, which we set out in the spring of the two previous years, is growing and spreading and is the best thing we have tired yet to hold the sand and secure on it a plant growth" (U.S. Army Corps of Engineers 1893[2](4):3340).

By August, 1893, the jetty was 9,700 feet long with another 900 feet to construct. As the project reached farther into the ocean, the workmen increased the length of piling to eighty feet. A newspaper account reported:

> These huge sticks are put down by the hydraulic process in a very short time after they are put in position, but with the driver on a tramway over 50 feet from the bottom great care must be exercised in handling such large timbers. It is often quite a job to get them in the desired position (Anonymous 1893a).

During the Corps projects on the North Spit two maritime mishaps occurred. The whaleback steamer, *C. H. Wetmore*, carrying a load of coal, got off course and stranded on the spit on September 8, 1892. It was a total loss (U.S. Army Corps of Engineers 1893[2](4):3341). In November, 1893, a massive cigar-shaped raft containing 3,500 piling destined for San Francisco broke free from its tow tugs. The raft, constructed by the San Francisco Bridge Company, first went aground on the south side of the bar near Guano Rock then moved on the flood tide and slammed into the north Jetty. "It has done much damage to the government work by striking against the piling," noted the local newspaper, "and has already destroyed several hundred feet of one of the tracks" (Anonymous 1893b). Corps officials estimated the damage at $700. The raft broke off seventy-one piling and damaged fifty-seven trestle bents. The ill-fated raft ultimately disintegrated in a storm off Cape Mendocino which scattered its logs for miles along the shore (U.S. Army Corps of Engineers 1894[2](4):2563, 2568).

In 1893-94 workmen extended the tramway to 9,520 feet, laying both center and side mattresses of brush to its termination (Figure 24). They also placed 117,340 tons of rock. The Corps officials were delighted with the results of the North Jetty project: "During the winter, as the enrockment slowly grew, a marked change took place in the bar channel, and a depth of 28

1/2 feet at ordinary high water was attained. A bar depth of 24 to 28 feet has been maintained ever since" (U.S. Army Corps of Engineers 1894[2](4):2562).

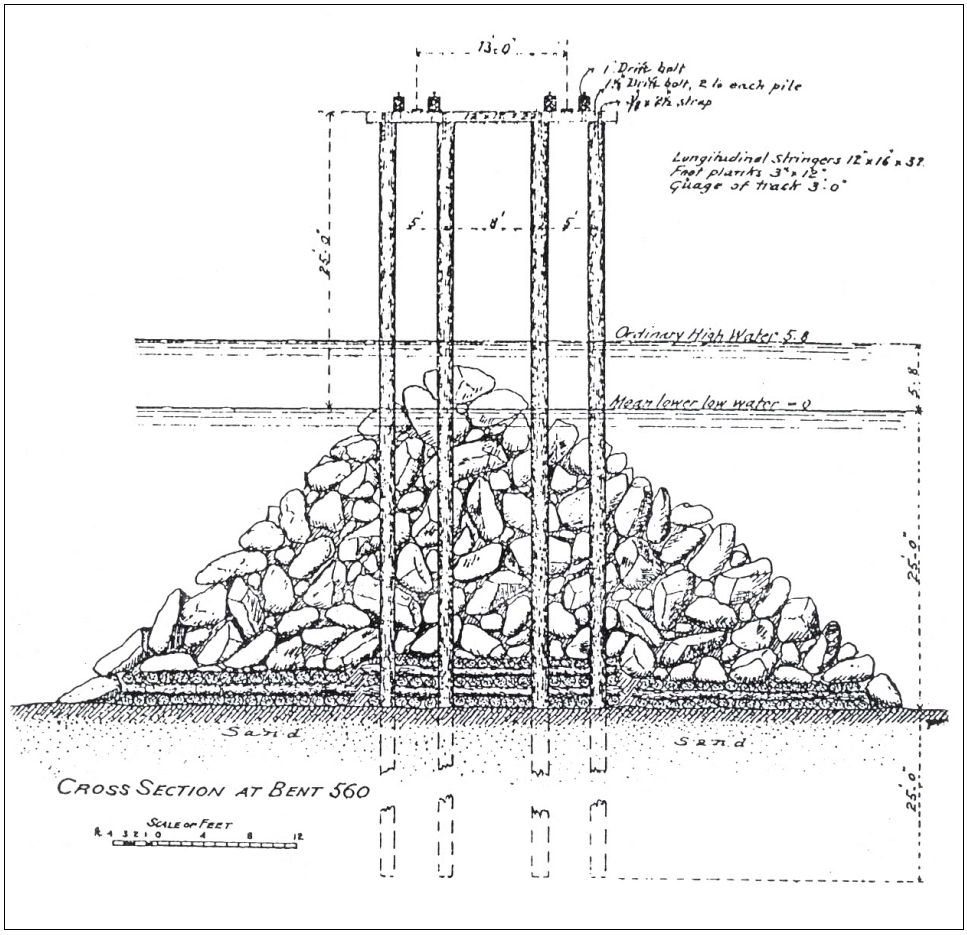

Fig. 24. Cross section of North Jetty at Bent 560 showing piling, center mattress, side mattresses (U.S. Army Corps of Engineers 1894[2](4):Section UU3).

The tramway was built to precise specifications (Figures 25 and 26). Polhemus told of the arrangement:

> The bents contain 4 piles each, and are spaced 16 feet apart, the caps are 12 by 12 inch square fir timbers, 22 feet long, driftbolted with two 24-inch bolts of 1 1/8 inch found iron in each pile. Four longitudinal 12 by 16 inch by 32 feet fir stringers,

fastened to the caps by 1-inch driftbolts, carry the 30-pound steel track rails (U.S. Army Corps of Engineers 1894[2](4):2566).

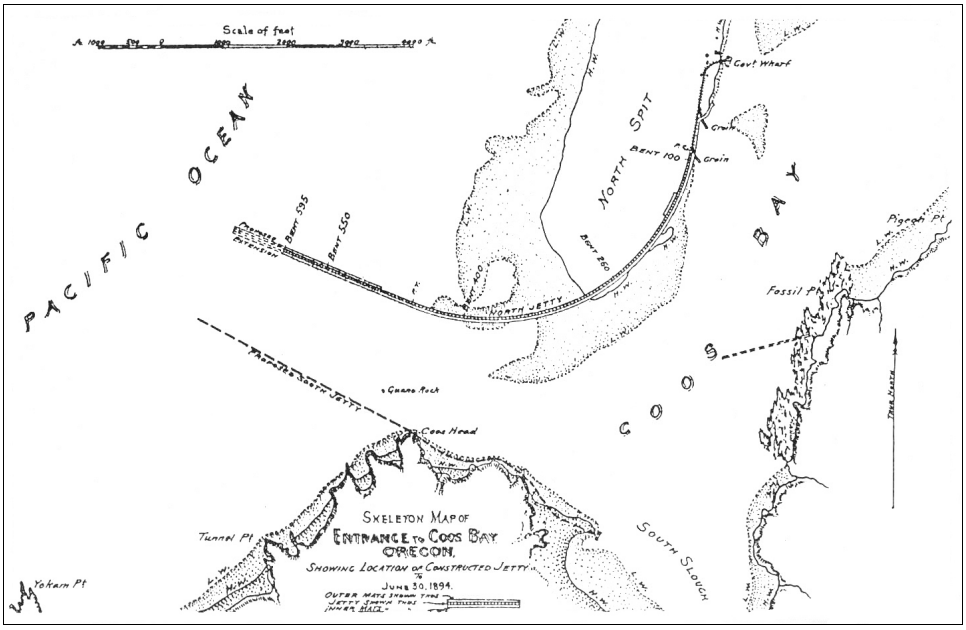

Fig. 25. North Jetty to Bent No. 595 and North Spit, June, 1894 (U.S. Army Corps of Engineers 1894[2](4):Section UU3).

A major project was to close the old swash channel between the southern end of the North Spit and the low water shoals which lay to the south. The Corps "Report of Operations" for 1893-94 spoke to this project:

> The mattress work went on until October, 1893, when it was finally completed for the length of the tramway constructed. After this was finished the work done consisted in receiving and placing stone in the jetty, which continued throughout the year. In order to facilitate the impounding of sand in the vicinity of the old swash channel, a sand catch was made by planking up the tramway between bents 209 and 281. Old and cheap lumber was used for this purpose. The result was very satisfactory. A high bank was established which forms the basis for a high-level accumulation seaward at a sufficient elevation for the establishment of plant growth (U.S. Army Corps of Engineers 1894[2](4):2563.

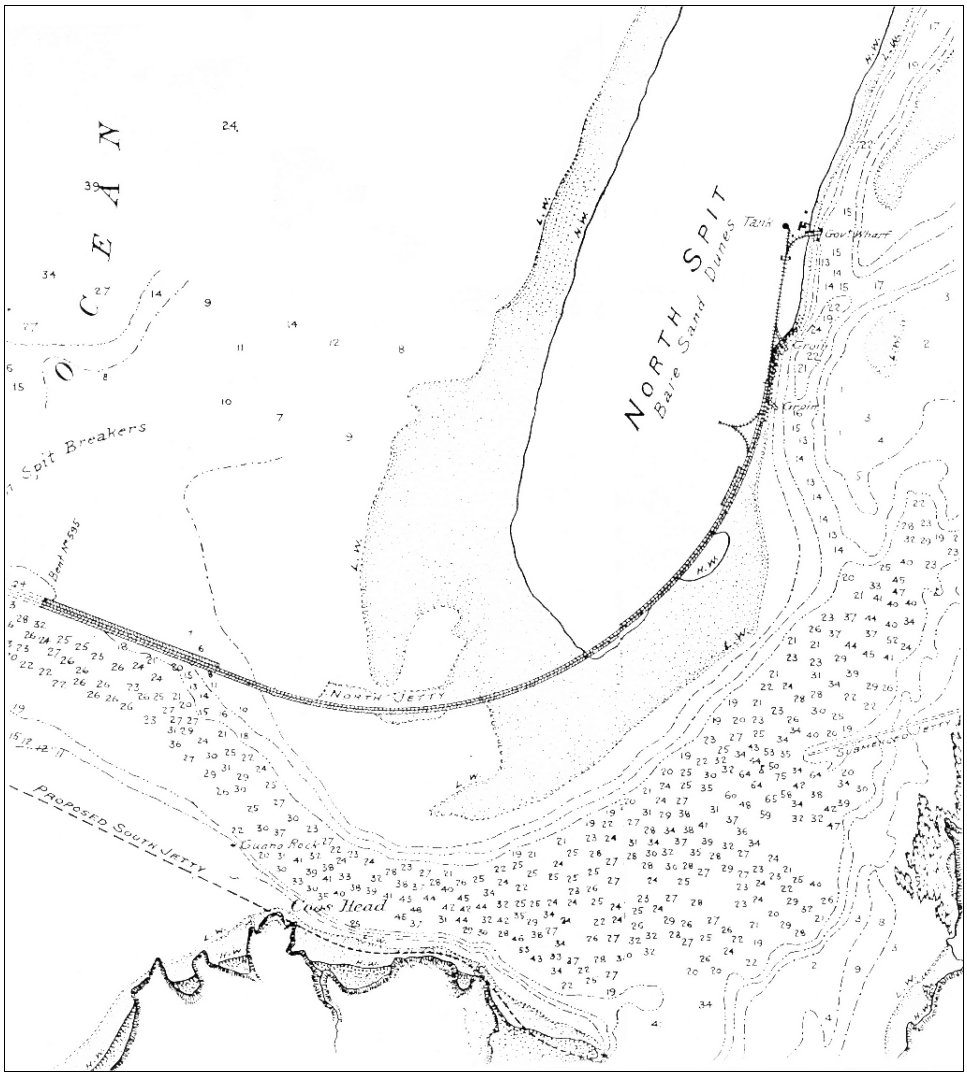

Fig. 26. Detail of North Spit, "Government Works" site, groins at Bents 65 and 115, documentation of accretion of sand south of Lot 3a (U.S. Army Corps of Engineers 1894[2](4):Section UU3).

The Corps discontinued reclamation work in the dunes and flats of the North Spit. It reported, however, that the plantings of Holland grass were thriving. "This has grown and thickened, and will soon be capable of subdivision into smaller roots and the planting of larger areas" (U.S. Army Corps of Engineers 1894[2](4):2565).